Southern Plains Inventory and Monitoring Network
Prioritization Workshop Report
January 24-25, 2006
Hosted by Alibates Flint Quarries Monument / Lake Meredith National Recreation Area
At the Ambassador Hotel, Amarillo, Texas

OVERVIEW

This two day workshop was attended by 44 people and continued the process of developing a long-term ecological monitoring program for natural resources in the Southern Plains Inventory and Monitoring Network (SOPN). In 2004 and 2005, SOPN held scoping sessions with park managers from each SOPN park, reviewed peer-reviewed literature and gray literature, and developed conceptual models for the major ecosystems in SOPN. In 2005, SOPN held two separate workshops, one in Cheyenne, Oklahoma with short-grass and mixed-grass breakout groups, and one in Las Vegas, New Mexico with rivers and streams, reservoirs, and landscape breakout groups. The breakout groups reviewed conceptual models for the major SOPN ecosystems and a list of potential ecological indicators or "vital signs". This process resulted in a list of 74 potential vital signs for consideration in our long-term monitoring program.

The goal of this workshop was to create a prioritized list of vital signs. Prior to the workshop, members of the technical committee lead each park in ranking the potential vital signs according to management significance. The workshop was divided up into four workgroups: plants and soils, wildlife, aquatic resources, and landscape level issues (see Table 1 for a complete list of participants and their workgroups). Each group reviewed a unique set of potential vital signs and ranked them according to ecological significance and feasibility / cost of implementation (Table 2). To calculate a total score for each potential vital sign, the following criteria were weighted as management significance (40%), ecological significance (40%), and feasibility / cost of implementation (20%). This process resulted in a prioritized list of vital signs for SOPN.

OBJECTIVES

1)   Develop a prioritized list of vital signs by evaluating potential vital signs according to three criteria.
2)   Review the highest ranked vital signs (top 25%) to get feedback from meeting participants on existing protocols and monitoring programs and potential partners.

DAY 1 – PRIORITZATION

The workshop started with a welcome from Karren Brown, Superintendent at Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument. Dusty Perkins then presented an overview of the Inventory and Monitoring Program, the SOPN, and the workshop process. In ranking ecological significance and feasibility / cost of implementation it was strongly emphasized that the workgroups stick to the pre-set criteria (See Appendix 1). Each criterion and the scoring system were reviewed as a group to minimize differences in definitions and interpretations between groups. The workshop was then divided into four workgroups, with a facilitator and notetaker in each group. The facilitators were all familiar with the I+M program and the vital signs process (two were network coordinators, one was a former network coordinator, and one was an ecologist that has helped SOPN and the Greater Yellowstone Network with the vital signs development process). All vital signs and the scoring process were contained in an access database.

Each workgroup worked through their list, one vital sign at a time, reviewing fields containing information on monitoring objectives, justifications, and potential measures. The goal was to try and reach consensus on scores for ecological significance and feasibility / cost of implementation. If, after some discussion it was clear that consensus would not be reached, the facilitator asked each member of the group for a score and the mean was taken. After completing

the scoring for all vital signs, the notetaker used the access database to create a report showing the prioritized list for that particular workgroup. The group was then asked to take one final look at the vital signs to ensure that ranking stayed consistent throughout the process and that the top vital signs were at or near the top of the list of vital signs. Each workgroup could also add vital signs to the list. Six new vital signs were added to the original 74 vital signs for a total of 80 potential vital signs (Table 2).

The workgroups were also encouraged to write additional comments for each vital sign that pertained to scoring, justifications, monitoring objectives, measures or other. All of the workgroups also had suggestions for merging and combining vital signs. A summary of these comments for each list is below

Plants and Soils
General Comments

Carbon balance – NDVI may not be the best measurement for soil carbon. Microsite soil core samples is the traditional method. This would have to be a composite measurement over a fixed area. Not likely to fluctuate much from year to year. Would only want to measure once every five years. Quite variable spatially. Sampling method needs to be consistent to reduce variability (composite sample). You will want to wrap carbon testing into determining other soil variables. This is only one variable of many that would be captured in a soil sampling method.

Grassland vegetation – Certain elements of the community are more variable than others: (less variable = basal area, richness, C3 vs. C4 ratios). The vital sign itself is quite variable both spatially and temporally. Labor will be the major cost factor. Repeatability will be dependant on what/how variable is measured. Need species level identification. Need large (adequate) samples and intensive monitoring. Comparability between different data gatherers will be difficult because there is less standardization of monitoring/sampling/etc.

Riparian vegetation – Not much standardization in sampling between agencies. USFS, BLM and WRD have their methods but it remains to be seen if those methods will fit NPS needs. There is a lot of research from tamarisk.

Non-vascular plants – Vital sign derived from lack of knowledge of lichen/bryophytes as opposed to air quality. Important to biodiversity and may be indicator link to overall health of ecosystem. Their may be indicator species as opposed to overall types. All responses are due to lack of knowledge and lack of an expert present and this should be taken into consideration. The group is NOT saying this does not count. This may have a park specific implication but low priority throughout the network.

Upland springs – This vital sign should look at rare fauna, water quality and water quantity, as well as vegetation. While a measure of park health, this may not be as strong as grassland extent and health. They are areas of high diversity and often contain T&E species.

Insect diseases / outbreaks on ecosystem – How would management use this data? It is difficult to apply the given criteria to this vital sign.

Woody invasive species – Mainly a land cover change issue, but there may be a structure issue.

Exotic plants – Need to focus in on key monitoring objectives, then develop measures. Needs to be cooperation between the I&M program and exotic plant management teams. Need to monitor what is there and how extensive vs. density of population. The vast majority of invasives are benign. Early detection and emphasis on species monoculture may be most cost effective. I&M needs to focus on early detection and change over time of the problematic species. Set priorities as species-based and which resources are at risk. At risk areas should be sampled more intensively.

Cryptobiotic soils – Crust in prairie lands may not serve as critical a function as in more arid areas. Change is so slow in crust recovery. Important where it exists.

Effects of park visitors on natural resources – This is an issue of "Human Carrying Capacity." May not affect what you monitor but where you monitor. Visitor use statistics may corroborate evidence of physical impacts.

Off-road vehicle use – Another case of where monitoring takes place, not necessarily new monitoring methods.

Fire and fuel dynamics – We assume wildland fire includes prescribed burns. From the viewpoint of the panel, this is primarily a vegetation community issue with a few additional measurements. Score based on vegetation vital signs.

Merging Suggestions
"Fire and fuel dynamics" and "woody invasives" should fit under the "vegetation communities (for wetlands, riparian, and grasslands). The soil vital signs should be reclassified into two new vital signs. "Soil chemistry and structure" would incorporate "carbon balance", "soil health as well as biological and physical elements, while "soil movement" would incorporate "erosion" and "soil budget".

Landscape
General Comments
The program should consider three different classes of vital signs: Drivers/Stressors, Ecological Response, and Aesthetics. The program should think outside of park boundaries when developing protocols and analyzing vital sign data. Think of spatial distribution of vital signs in regard to the three different classes.

Visibility and particulate matter – This is a viewscape issue, not an ecological issue (human impacts for viewing?). There should be a monitoring question relating to humans. Remove phosphates from list.

Wet and dry deposition – Dry is difficult to measure. Wet Deposition is easier/cheaper than dry.

Carbon balance – There was a range of agreement/disagreement for criteria. This is more of a response than an indicator. This vital signs does provide measure for management. The Justification Statement/Measures/Questions need to be reconsidered. Why is this under Category I (Air), Recommend moving to one of the soil vital signs. The sampling design would be critical.

Effects of wildlife diseases – Should add vectors, landscape structure, and reservoirs in surrounding landscape as a potential monitoring objective. Consider plant/animal pathogens, although plant pathogens need to be captured somewhere (another level III category) This vital signs is mixing apples and oranges.

Insect diseases / outbreaks on ecosystem – Should be renamed insect pests.

Mineral, oil, and gas extraction – This is a stressor to the environment (complex) and could be considered with human development. There was debate about whether this was for within or outside park boundaries

Human demographic data – This vital sign should analyze data in reference at different scales specifically relevant to each unit (e.g. viewshed, watershed, night skies, soundscape, etc.).

Effects of park visitors on natural resources – This vital signs needs to have a sensitivity of area to use factor (plant/soil topography). Should consider fragmentation issues. The monitoring objectives vs. measures doesn't track very well. This vital sign is not specific for the Level III classification. The vita sign could be renamed "People on the Landscape". This is an important driver with effects. There are well-established methods available.

Fire and fuel dynamics – This vital sign should monitor fuels and historic wildfire trends outside park boundaries.

Landscape dynamics – This vital sign should be considered as a landscape structure with aspects of use. The level III classification should be renamed "landscape dynamics" and this vital sign called "Landscape Structure".

Viewshed – The scale is critical (flat areas) vs. hills/mountains (much larger). The distance to height is critical to the impact.

New Vital Signs
This group added plant pathogens as a new vital sign. This vital sign would consider things like rust, oak wilt, sudden oak death, etc. The group noted that this new vital sign could be monitored with the existing insect outbreaks vital signs.

Merging Suggestions

The landscape group made the following recommendations for merging vital signs: "off-road vehicles" should be put under with "effects of park visitors on natural resources"; "extreme weather events" put under "weather patterns"; and "human development" under "landscape dynamics". The landscape group rated each one of vital signs that they recommended being incorporated into another vital sign a "0". This did not mean they felt it had no ecological significance or low feasibility score, but was merely a marker.

Wildlife

General Comments

Southwestern willow flycatcher – The group was split between 3 & 4 score for ecological significance. A more significant species would be to monitor yellow-billed cuckoo. The cost effectiveness score was based on abundance & distribution parameters only.

Mountain plovers – This species prefers fallow fields, "beat-up" habitats; often associated with prairie dog towns and is really being affected on their wintering grounds, esp. in CA. The vital signs should consider productivity in areas around parks, not just in the park lands. We don't really know what is causing decline, although the impacts to prairie-dog towns are a factor. Presence /absence data may be the best that can be accomplished because the species is found at such low densities across the landscape. With chicks, move in taller vegetation areas adjacent to nest sites. Productivity & survival may be important at park level vs. using patch-scale/regional breeding bird surveys, but more expensive.

Bald eagle – score based on wintering range.

Black-tailed prairie dogs – The scores are based on tracking distribution & size of towns over landscape, not density within a particular town.

Swift fox – They could be an indicator of changing carnivore communities (interspecies interaction with coyotes). The cost effectiveness score is based on doing distribution vs. recruitment or other demographic parameters

Townsend's big-eared bat – The group didn't have the expertise to make an educated guess on how to score the importance of this species. At least protect the known maternity/roost sites where this occurs at Capulin Volcano NM. It is important to have a better understanding of distribution & species occurrence of bats in general. Wind farms are an issue.

Ferruginous hawk – Winter monitoring may be more important & linked to presence of other raptor species (i.e. Eagles). Potential research questions: fledging dispersal; migratory patterns (talk to RMBO folks).

Texas horned lizard – What are trends & distribution of primary prey, harvester ant species across the parks? Should move this species into a reptile community vital sign.

Lesser prairie chicken – Species requires large areas of quality prairie habitat. Some in the group thought the habitat conditions may have passed a threshold.

Alberta arctic butterfly – This vital sign should be considered in new lepitodptera vital sign which are an indicator group for ecological changes. There are standard protocols already developed for monitoring butterflies. There was not enough expertise in the group to effectively score this vital sign.

Reptile community – The group feels the reptile/herp community is important to track. As a community, it may indicate problems with a particular situation (i.e. loss of short-grass prairies). Long-term monitoring of communities, any community is critical (decades vs. a few years). The sampling issues still need to be worked out. Bird abundance has a program DISTANCE/fixed radius point counts, etc.), but there are no counterparts for reptiles.

Bird communities – The existing monitoring protocols are specific to season & goals/objectives. By looking at communities, it provides improved data vs. single species monitoring or keystone/indicator species monitoring. Need to be specific at what techniques available, etc. You can't answer monitoring question two without breaking the bank.

Raccoons – This was not viewed as a network-wide vital signs, rather an individual park integrated pest management issue.

Large carnivores – The group did not consider coyotes as large carnivore; they are not a good indicator of the ecologic role of large carnivores. Coyotes were included in the medium sized carnivore vital sign.

Endemic and keystone invertebrates – Network should consider selecting groups of invertebrates that have well-established monitoring/sampling protocols. Narrow the scope of interest. The intent is admirable, but can you really identify keystone invertebrates in this system?

Insect diseases / outbreaks on ecosystem – Assumed looking at extent of damage & not individual/quantitative leaf-area damage.

Effects of wildlife diseases – A number of diseases can have impact on wildlife populations & impact visitors, i.e., chronic wasting disease, West Nile virus, plague, etc. This is important for park staff to be aware of the potential diseases in their area, who to contact, symptoms, collection of sample materials, etc. Wildlife disease may be more of the stressor in the system vs. the vital sign to monitor. It could be an annual reporting requirement (vital sign) of the parks, but there may not be a systematic monitoring program developed.

Feral dogs – Feral dogs/hogs/fire ants - vertebrate or invertebrate exotic species may be a better category of a vital sign. Dogs are also a big problem at CHIC.

Fire ants – We are considering imported fire ants, not native species.

Nutria – Don't expect nutria to be a problem in this network. Recommend close communication with state agencies, etc. to see if species is expanding its range.

Hunting / game animals – Getting handle on hunting pressures/take on game species needs to occur. Sounds like a permit system may need to be enacted. Issue hunter "cards", mail-in surveys, etc. Estimate of hunting pressure could be extrapolated to adjacent areas. Quantification of hunter pressure may be an important first step.

Effects of park visitors on natural resources – This is a stressor & not an effect.

New Vital Signs

This group added five new vital signs, butterflies, native pollinators, yellow-billed cuckoo, wintering raptors, and grasshoppers.

Butterflies were considered to be very sensitive to management actions and they may not be able to re-colonize once extirpated. Would serve as a good indicator of prairie health. From monitoring perspective, the monitoring protocols that currently exist are reliable for detecting trends over time. Rare, endangered species (this includes the Alberta arctic butterfly) will be picked-up in these types of monitoring protocols. Lepidoptera group has existing monitoring protocols & this group are host specialists with plants that are sensitive to climate change. Small isolated parks sensitive to habitat & climate changes. These parks may serve as refugia. Taxonomy is fairly stable. They may also provide subtle info on climate change.

Native pollinators are a functionally very important group, but as a group may be difficult to monitor because of the diversity (wasps, bees, moths, flies, beetles, hummingbirds, etc.). These vital signs would really be looking at plants via seed set/recruitment before these specific host plants suffer significant declines.

Yellow-billed cuckoos are extirpated from significant portion from most of its western range, "common" in the east. A species of concern in NM's wildlife strategies implementation plan & NM's PIF plan. May be a better indicator species than southwestern willow flycatcher; it's a riparian obligate in the western portion of its range. This species should be incorporated into sampling designs in the Bird Communities Vital Sign.

Wintering raptors could be incorporated into bird community vital signs. Potentially monitoring for contaminants may need to be considered in the prey species of raptors, as well as submit dead raptors to the USGS National Wildlife Health Lab in Madison, WI.

Grasshoppers are an alternative indicator for insect outbreaks vital sign. There is high interest to "neighbors" & other agencies (APHIS, ARS, others). Need to look at outbreak insect species in grasslands vs. forest/woodland situations. A lot of vegetation is eaten by grasshoppers. If keeping a database, you can get an indication when the next outbreak may occur. Looking for variability to be able to predict outbreaks. Weather explains approx. 25% of the variation in outbreaks. Number of data sets out there via APHIS.

Merging Suggestions

"Ferruginous hawks", "bald eagles", and "Mississippi kites" should all be under a new vital sign, "wintering raptors".

Aquatic Resources
General Comments
Exotic fish – This is redundant with fish communities, it is a subset. If monitoring was done independent of the whole community, it can be cost prohibitive.

Exotic plants – Insure that exotic plants are all vegetation protocols. This vital sign can have additional costs due to focusing only on exotic plants.

Effects of park visitors on natural resources – This is the cause and not the effect. It is an indicator of the magnitude of a stressor. This could be linked to a number of vital signs. Consider renaming this to "number of visitors". Visitor numbers can correlate to effects on park resources.

Flooding processes along streams/rivers/lakes – This is redundant with water quantity. Stream geomorphology might be a better name. The lake component is unnecessary.

Fecal coliform – This is no longer considered the most appropriate for surface water. E.coli is being used instead. Fecal coliform is now used for ground water. This vital sign should be incorporated into water quality.

Amphibian communities – Focus on anurans, not so much salamanders (frogs and toads more reliable, easier to have citizen science involved).

Merging Suggestions
The aquatic group thought that "off-road vehicles" should be merged with "effects of park visitors on natural resources". "Wetlands vegetation", "riparian vegetation", and "grassland vegetation", "exotic plants (by area)", should be merged into one new vital sign "vegetation communities. However, the early detection of exotic plants should be a stand alone vital sign. "Arkansas darter", "Arkansas river shiner", "fishing" and "exotic fish" should all be incorporated into "fish communities". "Sedimentation rates" should fit under "erosion". "E. coli (Fecal coli form)" should fit under water quality.

DAY 2 – ESSENTIAL VITAL SIGNS AND POTENTIAL PROTOCOLS, PROGRAMS, AND PARTNERS

On the second day, the prioritized list of vital signs by each criterion and by total score was presented (Tables 3-6). Vital signs that were rated in the top 25% were then given back to each workgroup for two final assignments. Each workgroup was asked if they felt there were any essential vital signs that were missing from the top 25%. The workgroup was also asked to brainstorm for potential existing protocols, existing monitoring programs, and potential partners for each one of the top vital signs. They were asked to brainstorm on vital signs that there group had reviewed the previous day first, and then go to any other vital signs in the top 25%. A summary of comments for each workgroup is below.

Plants and Soils
Essential Vital Signs
The group did not think that there were any essential vital signs missing from the top 25%.

Landscape
Essential Vital Signs
The group thought that human demographics and effects of park visitors on natural resources were essential vital signs. Human demographic data is relatively easy to get and is very useful to predict changes to the landscape. Changes in human demographics can have major impacts to resources (fertilization, run-off, air quality, water demand, exotic plants and animals, noise, light, trash, visitation, etc.). The effects of park visitors on natural resources is important because the data is easy to get and useful to predict changes. Visitors can have impacts on many natural resources (exotic plants, social trails, erosion, sewage, traffic, noise, sticky fingers, park infrastructure, and off-road vehicles. Both vital signs should take a landscape perspective with spatially explicit graphical representations of data.

Wildlife
Essential Vital Signs
        The wildlife group thought that black-tailed prairie dogs, the butterfly community, and fire ants were essential components to monitor. Black-tailed prairie dogs are keystone species that by being present can increase the chances that other rare fauna are present. In addition the group thought that burrowing owls could also be monitored at the same time as prairie dogs. Butterflies are important because they are sensitive indicators and respond quickly to changes in the environment. By monitoring a suite of species, you could obtain information about park management, but also how this biotic component is responding to changes at a landscape level. Fire ants were deemed essential due to the high impact this exotic species can have on ground-nesting birds, small mammals, invertebrates, reptiles, and amphibians.

Aquatic Resources
Essential Vital Signs
        The aquatic group felt thought both lotic fish communities and aquatic macroinvertebrate communities were essential vital signs. These vital signs are cheap to monitor, have well established protocols, and represent an important biotic component of water quality. The group also felt that monitoring spring communities was essential. This monitoring should include vegetation, rare fauna, and water quality/quantity issues. An inventory of historic and existing springs is essential.

Potential Protocols, Programs and Partners
Weather Patterns
        Protocols: Drought Monitor (Drought Mitigation Center at UNL), John Gross working on protocols, Kelly Redmond at DRI is working on climate inventories
        Programs: PRISM, NPS Fire Program, Texas Forest Service, Mesonet, LCRA
        Partners: National I&M John Gross, NWS, Maidment from UT Env. Eng. (developer of ArcHydro), Drought Mitigation Center (UNL), Environmental Events (UT), US Weather Service, NOAA

Soil Budget
        Protocols: Expect NRCS & USDA will be best source;
        Programs: Brian Tyler @ Fed Highways in Denver;
        Partners: Craig Allan (USGS) @ Bandelier; NRCS; Gary Lehrsch (ID) @ USDA-ARS, Stephen F. Austin University.

Soil Health
        Protocols: LTER Soils Manual Phil Robertson 1999 Oxford Press; Methods in Soil Science (book). NOTE: Health/Physical Properties and Soil Chemistry should be combined into one vital sign.
        Programs: NRCS (Pete Biggams can point in right direction);
        Partners – Pete Biggam (soil Scientist) @ NPS; Lorenz Sutherland (BEOL area), Greg Allen (WABA area) @ NRCS; Gene Kelly @ CSU (good advice). Stephen F. Austin University.

Water Quantity
        Protocols: USGS gauging programs
        Programs: USGS
        Partners: USGS, State water boards, Texas Water Development Board (TWDB), groundwater districts, river authorities, BOR, Army Corps

Water Quality
        Protocols: EPA, USGS, TCEQ. Use dataloggers instead of point measurements (where possible)
        Programs: Same as above
        Partners: EPA, TCEQ and other state water quality commissions, river authorities

Groundwater Levels
        Protocols: USGS, TCEQ, Texas Water Development Board (both deep and shallow)
        Programs: Same as above
        Partners: Water development boards, environmental quality commissions, groundwater districts

Woody Invasive Species
        Protocols: Prescribed fire protocols – NRCS, parks themselves, USFS, State forest services
        Programs:
        Partners:

Exotic Plants
        Protocols: Ask Brad Welch; Cynthia Huebner (USGS) invasives & understory in eastern forest (comparing protocols); adaptive sampling; remote sensing; Konza LTER for woody plants; NoCo Plateau Network (Tom O'Dell) for weed mapping; No Great Plains – Chad Prosser;
        Programs: EPMT; FirePro;
        Partners: Kendall Young @ Big Bend NP; Brad Welch for National Protocols; Craig Young @ HTLN; see also "Grassland Veg"; John Briggs @ AZ State (formerly Konza); Diane Larson @ USGS (NoPlains work); Mike Storey for Remote Sensing Stephen F. Austin University.

Wetland Vegetation Communities
        Protocols: NETN developing a set, Army Corps has identification protocols
EPA had new rapid assessment scorecard coming out (based on vegetation) – Can get from NETN
        Programs: NWI
        Partners: TNC, NPS, USFWS.

Riparian Vegetation Communities
        Protocols: ERMN developing riparian veg protocol. Develop permanent transects
NRCS may have some available (involved with Pecos River tamarisk control) (Mike Meechia (check spelling) involved from Fort Stockton, Farm Service Agency or NRCS – ask Glenn Longley. "Proper Functioning Condition" protocol – Joel Wagner @ NPS-WRD (online); BLM & USFS riparian assessments. COE Wetland Delineation; Ohio Dept of Natural Resources – (rapid assessment for wetland condition) Cayahoga Valley; HTLN may have expanded protocol info on Ohio DNR.
        Programs: Tamarisk removal initiative, FirePro, check with state Natural Heritage programs and Depts. of Natural Resources; National Wetland Inventory (NWI); USFWS manages wetlands.
        Partners: State, NRCS, USGS, TNC, BOR, Estevan Muldavin @ NHNM; David Cooper @ CSU, NRCS; Playa Lakes joint venture (USFWS); Joel Wagner, Kevin Noon – WRD; Society of Wetland Scientists webpage

Spring Communities
        Protocols: Rapid bioassessment, would be a need because no specific ones exist right now
        Partners: Texas State University

Grassland Vegetation Communities
        Protocols: USFS, BLM, USGS plant community monitoring protocols, Heartland Veg Protocol; SGS LTER protocol; Forest Service FIA;
        Programs: Fire Pro, EPMT
        Partners: TNC, Kelly Kindscher @ Kansas Biological Survey; Jennifer DeLisle @ KS Natural Heritage; John Blair @ Konza Prairie LTER; Bill Lauenroth @ SGS LTER; Scott Collins

@ Sevilleta LTER; Angie Evenden @ NoCO Plateau Network; Amy Symstad @ NoPlains Network. Stephen F. Austin University.

Lotic fish and macroinvertebrate communities
        Protocols: USEPA rapid bio assessment, Index Biotic Integrity (IBI), Barbor et al. 1999, Texas has receiving water assessments manual (TCEQ), USGS NAWQA program, EPA biological condition gradient
        Partners: State game and fish agencies

Amphibian Communities
        Protocols: Amphibian and reptile monitoring initiative (ARMI), USGS, Frogwatch. ARMI protocol may not work very well in this region.; frog loggers; PARC
        Programs: PARC, NMFWA (National Military Fish & Wildlife Association) Herp Working Group, state non-game departments, state heritage programs, areas universities, USGS ARMI
        Partners: ARMI,TNC, Frogwatch, PARC, NMFWA Herp Working Group, state non-game departments, state heritage programs, areas universities, USGS BRD, USFWS (refuges)

Bird Communities
        Protocols: HTLN Peitz & Fancy protocol; point transects stratified by habitat; BBS, MAPS, CBC, individual species (yellow-billed cuckoo, southwestern willow flycatcher, long-billed curlew, lesser prairie chicken, burrowing owl, ferruginous hawks); specific training to be able to identify key species; seasonal component (breeding & winter for wintering raptors)
        Programs: BBS; Partners in Flight; BBS, CBC, MAPS, state PIF plans national PIF monitoring plan & protocols, MOSI (monitoring overwinter survival), Bald Eagle Watch, Avian Knowledge Network (Cornell OL), RMBO point transect program, state mourning dove counts, NM Burrowing Owl Working Group/surveys. Should review state PIF plans & state wildlife conservation strategy plans for habitats & species already identified for monitoring, state heritage programs
        Partners: Brett Sandercock @ Konza; David Peitz @ HTLN; David Hanni @ Rocky Mountain Bird Observatory; Fritz Knopf @ USGS(?) in CO; Larkin Powell @ U of Nebraska, state game & fish depts., RMBO, Cornell, USGS, Audubon, Joint Ventures (Intermountain, Playa), Forest Service, USFWS, state PIF working groups, NM Burrowing Owl Work Group, Hawk Watch International, Institute for Bird Populations, Ducks Unlimited, Quail Unlimited, state wildlife federation chapters, area universities

Small Mammal Communities
        Protocols: CDC (rodent protocols), Allen O'Connell (USGS Patuxant) and Baccus do small mammal monitoring. Wildlife Techniques published by The Wildlife Society, mark/recaputure, permanent trapline transects stratified by habitat; could tie into spot lighting surveys
        Programs: LTER, LCTA (Land Condition Trend Analysis on DOD lands), area universities, state heritage programs
        Partners: Cheryl Schmidt @ independent SD – surveys No Plains; Jennifer DeLisle @ KS Biological Survey; Mike Bogan @ USGS; UNM has good small mammal biologists; Lynn Robbins @ MO State, state game & fish departments, ARS, DOD

Ungulates
        Protocols: 72 oz protocol, spot light surveys, aerial surveys, 'drive' counts, distance sampling, check stations (age & sex ratios) , could make note of other mammal species.
        Programs: state game & fish departments
        Partners: The Big Texan, Kroll @ SFA (white-tail); Sam Fuhlendorf (grazing) @ OK State; Ben Bobowski @ NPS; Bob Hamilton (TNC) @ Tallgrass Prairie Preserve, state game & fish departments, Rocky Mountain Elk Foundation, Mule Deer Foundation, IUCN (bison genetics issues), state Wildlife Federation Chapters, area universities, local sporting groups, scouting organizations

Fire and Fuel Dynamics

Protocols: Texas Agricultural Extension Unit, John Baccus from Texas State San Marcos, Fire PRO. Look at plot replication for determining fire effects/fuel load/other stuff. Address fuel load outside park units. Drought, Extreme Weather Events, Human Influence, Exotics, Abandoned Agriculture Lands, Removal of grazing all need to be considered. Fire Monitoring Handbook; Nested frequencies; HTLN veg protocol;

Programs: Fire PRO, Land Fire, USFS Fire and Fire Surrogates Program, State Forestry Programs, GPCESU/DSCESU Fire History of Capulin, USGS – Fire History of the Great Plains, FirePro; USFS Fire Science in Boise;

Partners: USFS, BLM, NPS, TNC, Federal Interagency Fire Program, Drought Mitigation Center (UNL), David Heartnet @ Konza; Jim DeCoster, Linda Kerr @NPS fire ecologists; Kara Paintner @ NPS fire/bio liaison; Cody Wienk @ No Great Plains fire ecologist; Dave Engel @ Iowa State; Sam Fuhlendorf @ OK State; Mark Paschke @ CSU; Carlton Britton @ TX Tech.

Landscape Dynamics

Protocols: National Capitol region, John Gross WASO is developing LU/LC protocols. They should include SOPN lands and surrounding regions and should use human census/demographic data. The monitoring frequency may vary. Available for use: MODIS, ASTER, IKONOS, Quick Bird, LANDSAT, SPOT. Recommend development of time series of historical and projected future trends

Programs:

Partners: USGS (MRLC), NASA, GAP, EPA, TNC, State Heritage Programs, National Wetland Inventories, State Resource Surveys, USDA (NAIP), Ducks Unlimited, NOAA, Jim Merchant @ CALMIT; Kevin Price @ U of KS; Andy Hansen @ Montana State; Robert Weih @ U of Arkansas-Monticello; David Kulhavy @ SFA;

Human Demographics

Protocols: GCCESU already working on this, spatially explicit graphical representations, Landscape perspective (not just numbers)

Programs/Partners: US Census econ/soc/demo data, Jim Gramann, NPS, Visitor Survey Program

Viewshed

Protocols: DSC (planning), USFS (scenic beauty estimation method), Planning team at Sand Creek, NPS Air resources division (class I parks), Cell Towers/Wind Farms/Utilities (EIS Statements)

Programs:

Partners: SHPO

Table 1. List of workshop participants. A (F) denotes the facilitator and an (N) denotes the notetaker for each workgroup.

Person	Organization	Expertise
Participants by Workgroup		
Person	*Organization*	*Expertise*
Plants and Soils Group		
Mike DeBacker (F)	National Park Service – Heartlands I+M Network	Prairie vegetation, long-term monitoring
Tomye Folts Zettner (N)	Texas A+M Graduate Student	Vegetation
Tim Seastedt	University of Colorado	Soils, invasive plants, long-term monitoring
Brad Welch	National Park Service	Invasive plants
Pam Benjamin	National Park Service	Vegetation
James Stubbendieck	University of Nebraska	Grasslands
Alan Knapp	Colorado State University	Grassland vegetation, global climate change, monitoring
Karie Cherwin	Southern Plains Associate	Soils, restoration
Fran Pannebaker	Bent's Old Fort NHS	Chief of Natural Resources
Brian Quigley	Capulin Volcano NM	Chief Ranger
Ted Benson	Pecos NHP	Ranger, Natural Resources
Felix Revello	Fort Larned NHS	Chief Ranger
Wildlife Group		
Dan Licht (F)	National Park Service – Northern Great Plains Network	Grassland vertebrates, long-term monitoring
Hildy Reiser (N)	National Park Service – Chihuahuan Network	Desert ecology, long-term monitoring
Roel Lopez	Texas A+M University	Wildlife Ecology, GPS, GIS
Anthony Joern	Kansas State University	Grazing, bison, invertebrates
David Hanni	Rocky Mountain Bird Observatory	Grassland birds
Jeff Kelly	University of Oklahoma	Vertebrate Ecology
Ray Matlack	West Texas A+M	Mammalian ecology
John Hughes	US Fish and Wildlife Service	Grazing, burning, vertebrates
Steve Burrough	Chickasaw NRA	Chief of Resource Management
Arlene Wimer	Lake Meredith NRA / Alibates Flint Quarries NM	Environmental Specialist
Aquatic Resources Group		
Greg Shriver (F)	University of Delaware	Long-term monitoring, avian ecology
Heidi Sosinski (N)	Southern Plains Network	Data Manager
Tim Bonner	Texas State University	Fish, stream ecology
Kevin Noon	National Park Service	Wetland Ecology
Don Huggins	University of Kansas	Aquatic ecology, entomology
Glen Longley	Texas State University	Edwards Aquifer Water Quality
Matt Whiles	Southern Illinois University	Vertebrates, stream ecology
Melissa Trammell	National Park Service – Intermountain Region	Fisheries
Paul Eubank	Lake Meredith NRA / Alibates Flint Quarries NM	Chief of Resource Management
Landscape Issues Group		
Dan Tinker (F)	University of Wyoming	Conceptual modeling, forest ecology

Jason Lott (N)	Lyndon B. Johnson NHP	Integrated Resource Specialist
Michael Huston	Texas State University	Landscape ecology
Mike Story	National Park Service	Remote sensing
Kathy Tonnessen	NPS – Rocky Mountain Cooperative Ecosystems Studies Unit	Air Quality
Gillian Bowser	NPS- Gulf Coast Cooperative Ecosystems Studies Unit	Genetics, vertebrate landscape ecology
Gary Willson	NPS – Great Plains Cooperative Ecosystems Studies Unit	Grasslands, fire
Doug Goodin	Kansas State University	Climate, remote sensing
Carol Wessman	University of Colorado	Landscape ecology, woody invasion
Alexa Roberts	Sand Creek Massacre NHS	Superintendent
Tulia DeFex	Texas A+M Graduate Student	Landscape dynamics
Floaters		
Karren Brown	Lake Meredith NRA / Alibates Flint Quarries NM	Superintendent
Dusty Perkins	Southern Plains Network	Network Coordinator

Table 2. List of vital signs reviewed at the prioritization workshop. The list includes 74 vital signs on the original list and 6 new vital signs that were added at the workshop for a total of 80 vital signs. Vital signs in italics were added at the workshop

Southern Plains Network Potential Vital Signs

The following list represents SOPN's potential vital signs organized into the NPS Ecological Monitoring Framework. This framework is a systems-based, hierarchical, organizational tool for promoting communication, collaboration, and coordination among parks, networks, programs, and agencies involved in ecological monitoring. Vital signs selected by parks and networks for monitoring are assigned to the Level 3 category that most closely pertains to that vital sign.

Level 1	Level 2	Level 3	Vital Sign	Plants /Soils (19)	Wildlife (35)	Aquatic Resources (25)	Landscape / Other (20)
Air and Climate	Air Quality	Wet and Dry deposition	Wet and dry deposition				X
		Visibility and Particulate matter	Visibility and particulate matter				X
	Weather and Climate	Weather and Climate	Weather patterns				X
			Carbon balance in soil	X			X
Geology and Soils	Geomorphology	Stream/River Channel Characteristics	Erosion – slopes, lakeshores, banks			X	
		Hillslope Features and Processes	Volcanic cinder cone	X			
	Soil Quality	Soil Function and Dynamics	Soil health	X			
			Cryptobiotic soils	X			
			Erosion index	X			
			Soil budget (inflow/outflow)	X			
Water	Hydrology	Groundwater Dynamics	Groundwater			X	

			levels				
		Surface Water Dynamics	Water quantity			X	
			Flooding processes along river/ stream/ lake			X	
			Sedimentation rates			X	
	Water Quality	Water Chemistry	Water quality			X	
		Toxics	Fecal coliform			X	
			Contaminants in fishery/food chain			X	
		Aquatic Macroinvertebrates and Algae	Aquatic invertebrates (riverine systems)			X	
Biological Integrity	At-risk Biota	T&E Species and communities	Bald Eagle		X	X	
			Arkansas river shiner			X	
			Arkansas darter			X	
			Alberta Arctic butterfly		X		
			Black-tailed prairie dogs		X		
			Burrowing Owl		X		
			Ferruginous hawk		X		
			Lesser prairie chicken		X		
			Mountain plover		X		
			Southwestern		X		

			willow flycatcher				
			Swift fox		X		
			Texas horned lizard		X		
			Townsend's big-eared bat		X		
			Yellow-billed cuckoo		*X*		
	Focal Species or Communities	Wetland Communities	Upland springs – vegetation communities	X		X	
			Wetlands – vegetation communities	X		X	
		Riparian Communities	Riparian community – vegetation communities	X		X	
		Freshwater Communities	Lacustrine community – Plankton richness, abundance, and diversity			X	
		Grassland/Herbaceous Communities	Grassland Vegetation	X			
		Vegetation Communities	Non-vascular plants	X			X
			Montane/grass land ecotone	X			X
		Birds	Migratory stopover area		X		
			Mississippi kites		X		
			Bird		X		

			Communities				
			Wintering Raptors		*X*		
		Mammals	Large carnivores		X		
			Medium-sized (meso) carnivores		X		
			Small mammal communities		X		
			Raccoons		X		
			Ungulates		X		
		Fish	Fish communities (riverine systems)			X	
		Terrestrial Invertebrates	Endemic + keystone invertebrates	X	X		
			Butterflies and Moths		*X*		
			Grasshoppers		*X*		
			Native Pollinators		*X*		
		Amphibians and reptiles	Reptile community		X		
			Amphibian Community		X	X	
	Invasive Species	Invasive/Exotic plants	Woody invasive species	X			
			Exotic plants	X		X	
		Invasive/Exotic animals	Zebra mussels			X	
			Nutria		X	X	
			Exotic Fish			X	
			Exotic		X		

			ungulates				
			Feral Dogs		X		
			Feral Hogs		X		
			Fire Ants		X		
	Infestations and disease	Insect pests	Insect diseases/ outbreaks on ecosystem	X	X		X
		Animal diseases	Effects of wildlife diseases		X		X
		Plant Diseases	*Plant Pathogens*				*X*
Human Use	Consumptive Use	Consumptive Use	Mineral, oil, and gas extraction				X
			Hunting / Game animals		X		
			Fishing			X	
	Visitor and Recreation Use	Visitor usage	Effects of park visitors on natural resources	X	X	X	X
			Off-road vehicle use	X	X	X	X
	Non-point source human effects	Non-point source human effects	Demographic data (human density, traffic volume, land ownership patterns, land value)				X
Landscapes (Ecosystem Patterns and Processes)	Viewscape	Viewscape/Night Sky	Viewshed				X
			Night sky				X

	Fire	Fire and Fuel Dynamics	Fire and fuel dynamics	X			X
	Landscape Dynamics	Landscape Dynamics	Landscape dynamics (land cover, condition, connectivity, pattern, land change)				X
			Human Development (Road density, impervious cover, house density				X
	Extreme disturbance events	Extreme disturbance events	Tornadoes, record floods, ice storms				X
	Soundscape	Soundscape	Soundscape				X

Table 3. Management Significance Ranking Results - Sorted by Average Score.

Potential Vital Sign	Average Score	ALFL	BEOL	CAVO	CHIC	FOLS	FOUN	LAMR	LYJO	PECO	SAND	WABA
Exotic plants	**4.55**	4	4	5	5	5	5	4	4	5	4	5
Grassland Vegetation	**4.45**	4	4	5	5	5	4	3	5	4	5	5
Woody invasive species	**4.09**	4	4	5	5	3	4	4	4	4	3	5
Fire and fuel dynamics	**3.91**	0	3	5	5	4	3	4	5	4	5	5
Bird Communities	**3.82**	3	3	5	4	3	4	3	4	4	5	4
Ungulates	**3.45**	4	1	4	5	2	2	3	5	4	5	3
Riparian community – vegetation communities	**3.45**	4	4	0	5	4	0	3	4	4	5	5
Water quantity	**3.36**	0	4	0	5	3	4	4	4	4	4	5
Viewshed	**3.18**	3	4	3	3	4	3	0	4	4	4	3
Effects of park visitors on natural resources	**3.09**	3	0	2	5	0	4	3	4	4	4	5
Small mammal communities	**3.00**	2	3	4	5	0	4	2	3	4	3	3
Erosion – slopes, lakeshores, banks	**2.91**	0	1	5	4	4	4	0	3	4	4	3
Water quality	**2.91**	0	2	0	5	2	3	4	5	5	3	3
Groundwater levels	**2.73**	0	4	1	5	2	3	0	3	3	4	5
Reptile community	**2.64**	2	2	3	4	0	3	3	3	3	2	4
Wetlands – vegetation communities	**2.64**	0	4	0	5	0	3	0	3	4	5	5
Weather patterns	**2.55**	4	3	3	2	1	3	2	4	3	3	0
Amphibian Communities	**2.55**	2	2	0	4	2	3	3	3	3	2	4
Soil budget (inflow/outflow)	**2.55**	0	2	3	3	4	2	0	3	2	4	5
Erosion index	**2.55**	0	2	4	3	3	2	0	3	2	4	5
Migratory stopover area	**2.45**	2	3	3	4	0	2	2	3	3	5	0
Soil health	**2.45**	0	2	4	3	0	3	0	3	3	4	5
Night sky	**2.45**	2	2	3	0	0	3	3	4	3	2	5
Flooding process along river / stream / lake	**2.36**	0	4	0	3	3	0	0	4	3	4	5
Landscape dynamics	**2.27**	0	2	0	5	3	1	0	3	3	3	5
Soundscape	**2.27**	2	1	1	4	0	2	3	3	2	2	5
Human Development	**2.09**	0	1	0	5	2	3	0	3	4	2	3

Potential Vital Sign	Average Score	ALFL	BEOL	CAVO	CHIC	FOLS	FOUN	LAMR	LYJO	PECO	SAND	WABA
Wet and dry deposition	2.00	2	3	5	1	0	0	0	2	0	4	5
Medium-sized (meso) carnivores	2.00	2	1	4	3	0	2	0	2	3	2	3
Effects of Wildlife diseases	2.00	0	2	3	4	0	3	0	4	3	3	0
Fecal Coliform	2.00	0	1	0	5	1	0	4	4	1	3	3
Upland springs – vegetation communities	1.91	0	1	0	5	0	2	0	3	2	3	5
Human Demographic data	1.91	0	1	2	5	3	1	0	3	4	2	0
Insect diseases / outbreaks on ecosystem	1.82	0	2	3	4	0	1	0	4	4	2	0
Visibility and particulate matter	1.73	2	2	5	1	0	1	2	2	1	2	1
Carbon balance in soil	1.73	0	3	0	3	0	2	0	0	2	4	5
Texas horned lizard	1.73	3	1	0	4	0	1	3	3	1	0	3
Fish communities (riverine systems)	1.73	2	2	0	4	0	0	0	3	3	2	3
Large carnivores	1.73	0	1	4	3	0	2	0	2	4	0	3
Aquatic invertebrates (riverine and palustrine systems)	1.73	0	2	0	4	0	0	0	4	2	2	5
Contaminants in fishery/food chain	1.73	0	1	0	5	0	0	3	3	4	0	3
Endemic and keystone invertebrates (terrestrial systems)	1.55	0	2	3	3	0	1	0	2	1	2	3
Black-tailed prairie dogs	1.45	0	4	0	0	5	2	0	0	0	5	0
Cryptobiotic soils	1.36	0	0	0	4	0	1	0	0	2	3	5
Tornadoes, record floods, ice storms	1.36	0	3	0	3	0	1	0	4	1	3	0
Bald Eagle	1.27	2	0	2	3	0	0	0	3	3	1	0
Mississippi kites	1.27	3	1	0	4	0	0	3	0	0	0	3
Montane / grassland ecotone	1.27	0	0	5	0	0	3	0	0	1	0	5
Mineral, oil, and gas extraction	1.27	4	0	0	0	0	0	4	0	0	2	4
Sedimentation rates	1.27	0	3	0	3	0	0	0	4	1	0	3
Ferruginous hawk	1.09	2	1	0	0	0	2	0	0	2	5	0
Non-vascular plants	1.09	0	0	4	1	0	1	0	2	1	0	3
Feral Hogs	1.09	0	0	0	5	0	0	0	2	0	5	0
Fishing	1.09	0	1	0	5	0	0	0	2	4	0	0
Exotic Fish	1.00	0	1	0	5	0	0	0	3	2	0	0

Potential Vital Sign	Average Score	ALFL	BEOL	CAVO	CHIC	FOLS	FOUN	LAMR	LYJO	PECO	SAND	WABA
Mountain plover	**0.91**	2	0	0	0	0	0	0	0	3	5	0
Burrowing Owl	**0.91**	2	1	0	1	0	1	0	0	0	5	0
Feral Dogs	**0.91**	0	0	0	4	0	0	0	2	4	0	0
Fire Ants	**0.91**	0	0	0	5	0	0	0	5	0	0	0
Exotic ungulates	**0.82**	0	0	0	4	0	0	0	5	0	0	0
Hunting / Game animals	**0.82**	0	0	0	5	0	0	4	0	0	0	0
Arkansas darter	**0.73**	0	2	0	1	0	0	0	0	0	5	0
Lesser prairie chicken	**0.73**	0	0	0	0	0	0	0	0	0	5	3
Lacustrine community	**0.73**	0	0	0	5	0	0	2	0	1	0	0
Raccoons	**0.73**	0	1	0	5	0	0	0	2	0	0	0
Arkansas river shiner	**0.64**	3	0	0	0	0	0	4	0	0	0	0
Swift fox	**0.55**	0	1	0	0	0	0	0	0	0	5	0
Zebra mussels	**0.55**	0	0	0	4	0	0	0	2	0	0	0
Nutria	**0.55**	0	0	0	3	0	0	0	3	0	0	0
Off-road vehicle use	**0.55**	0	0	0	2	0	0	4	0	0	0	0
Southwestern willow flycatcher	**0.45**	2	0	0	0	0	0	0	0	3	0	0
Townsend's big-eared bat	**0.45**	0	1	4	0	0	0	0	0	0	0	0
Alberta Arctic butterfly	**0.45**	0	0	5	0	0	0	0	0	0	0	0
Volcanic cinder cone	**0.45**	0	0	5	0	0	0	0	0	0	0	0

Table 4. Ecological significance scoring results. An "NR" denotes the item was not actually ranked due to lack of expertise with that particular vital sign.

Score	Potential Vital Sign
5.00	Soil health
5.00	Water quality
5.00	Groundwater levels
5.00	Weather patterns
5.00	Riparian community – vegetation communities
5.00	Woody invasive species
5.00	Landscape dynamics (land cover, condition, connectivity, pattern, land change)
5.00	Fire and fuel dynamics
5.00	Wet and dry deposition
5.00	Wetlands – vegetation communities
5.00	Water quantity
5.00	Volcanic cinder cone
5.00	Grassland Vegetation
5.00	Fish communities (riverine systems)
5.00	Human Demographic data (human density, traffic volume, land ownership patterns, land value)
5.00	Lesser prairie chicken
5.00	Amphibian Communities
5.00	Aquatic invertebrates (riverine and palustrine systems)
5.00	Soil budget (inflow/outflow)
5.00	Yellow-billed cuckoo
4.75	Bird Communities
4.70	Plant Pathogens
4.50	Insect diseases / outbreaks on ecosystem
4.50	Small mammal communities
4.50	Upland springs – vegetation communities
4.50	Ungulates
4.50	Fire Ants
4.00	Arkansas river shiner
4.00	Lacustrine community – Plankton richness, abundance, and diversity
4.00	Arkansas darter
4.00	Ferruginous hawk
4.00	Large carnivores
4.00	Feral Hogs
4.00	Black-tailed prairie dogs
4.00	Exotic plants
4.00	Visibility and particulate matter
4.00	Other native pollinators
4.00	Lepidoptera

Score	Potential Vital Sign
4.00	Mineral, oil, and gas extraction
4.00	Cryptobiotic soils
4.00	Sedimentation rates
4.00	Carbon balance in soil
4.00	Erosion – slopes, lakeshores, banks
4.00	Flooding process along river / stream / lake
4.00	Viewshed
4.00	Texas horned lizard
3.90	Soundscape
3.75	Burrowing Owl
3.70	Night sky
3.60	Effects of Wildlife diseases
3.50	Southwestern willow flycatcher
3.50	Grasshoppers
3.50	Montane / grassland ecotone
3.38	Effects of park visitors on natural resources
3.00	Exotic ungulates
3.00	Mountain plover
3.00	Wintering raptors
2.00	Zebra mussels
1.50	Mississippi kites
1.50	Endemic and keystone invertebrates (terrestrial systems)
1.50	Medium-sized (meso) carnivores
1.50	Swift fox
1.50	Reptile community
1.00	Exotic Fish
1.00	Non-vascular plants
1.00	Feral Dogs
1.00	Fecal Coliform
1.00	Nutria
1.00	Hunting / Game animals
0.75	Raccoons
0.50	Off-road vehicle use
0.50	Migratory stopover area
0.50	Bald Eagle
0.00	Fishing
0.00	Erosion index
0.00	Contaminants in fishery/food chain
0.00	Tornadoes, record floods, ice storms
0.00	Human Development (Road density, impervious cover, house density
NR	Alberta Arctic butterfly
NR	Townsend's big-eared bat

Table 5. Feasibility and Cost of Implementation scoring results. An "NR" denotes the item was not actually ranked due to lack of expertise with that particular vital sign.

Score	Potential Vital Sign
5.00	Burrowing Owl
5.00	Fecal Coliform
5.00	Water quantity
5.00	Water quality
5.00	Groundwater levels
5.00	Fire Ants
5.00	Weather patterns
5.00	Woody invasive species
5.00	Wetlands – vegetation communities
5.00	Montane / grassland ecotone
5.00	Fishing
5.00	Lesser prairie chicken
5.00	Zebra mussels
5.00	Bird Communities
5.00	Arkansas darter
5.00	Ferruginous hawk
5.00	Swift fox
5.00	Black-tailed prairie dogs
5.00	Arkansas river shiner
5.00	Mississippi kites
5.00	Bald Eagle
5.00	Southwestern willow flycatcher
5.00	Mineral, oil, and gas extraction
5.00	Lacustrine community
5.00	Grassland Vegetation
5.00	Yellow-billed cuckoo
5.00	Lepidoptera
5.00	Amphibian Communities
5.00	Human Demographic data
5.00	Ungulates
5.00	Fish communities (riverine systems)
5.00	Aquatic invertebrates (riverine and palustrine systems)
5.00	Soil health
5.00	Soil budget (inflow/outflow)
5.00	Landscape dynamics
4.80	Viewshed
4.50	Upland springs – vegetation communities
4.50	Grasshoppers
4.50	Riparian community – vegetation communities

Score	Potential Vital Sign
4.50	Exotic plants
4.50	Small mammal communities
4.50	Migratory stopover area
4.33	Insect diseases / outbreaks on ecosystem
4.30	Plant Pathogens
4.05	Carbon balance in soil
4.00	Feral Hogs
4.00	Erosion – slopes, lakeshores, banks
4.00	Volcanic cinder cone
4.00	Hunting / Game animals
4.00	Flooding process along river / stream / lake
4.00	Exotic Fish
4.00	Non-vascular plants
4.00	Sedimentation rates
4.00	Contaminants in fishery/food chain
4.00	Visibility and particulate matter
4.00	Wet and dry deposition
4.00	Fire and fuel dynamics
4.00	Feral Dogs
3.50	Large carnivores
3.50	Nutria
3.50	Medium-sized (meso) carnivores
3.33	Effects of park visitors on natural resources
3.00	Wintering raptors
3.00	Mountain plover
3.00	Other native pollinators
3.00	Cryptobiotic soils
3.00	Raccoons
3.00	Exotic ungulates
3.00	Texas horned lizard
2.50	Night sky
2.25	Effects of Wildlife diseases
2.00	Reptile community
1.00	Soundscape
1.00	Endemic and keystone invertebrates (terrestrial systems)
0.75	Off-road vehicle use
0.00	Human Demographic data (human density, traffic volume, land ownership patterns, land value)
0.00	Erosion index
0.00	Tornadoes, record floods, ice storms
NR	Alberta Arctic butterfly
NR	Townsend's big-eared bat

Table 6. Final vital signs prioritization list. The shaded vital signs represent the top 25%. An "*" denotes this vital sign was scored a 0 by the landscape group because they felt it was incorporated by another vital signs. An "^" denotes this vital sign was scored a 0 by the plants and soils group because they felt it was incorporated by another vital signs. An "NR" denotes the item was not actually ranked due to lack of expertise with that particular vital sign.

Potential Vital Sign	Total Score	Management Significance	Ecological Significance	Cost Effectiveness and Feasibility
Grassland Vegetation	4.78	4.45	5.00	5.00
Woody invasive species	4.64	4.09	5.00	5.00
Bird Communities	4.42	3.81	4.75	5.00
Fire and fuel dynamics	4.36	3.90	5.00	4.00
Water quantity	4.34	3.36	5.00	5.00
Exotic plants	4.32	4.54	4.00	4.50
Riparian community – vegetation communities	4.28	3.45	5.00	4.50
Ungulates	4.18	3.45	4.50	5.00
Water quality	4.16	2.90	5.00	5.00
Groundwater levels	4.09	2.72	5.00	5.00
Wetlands – vegetation communities	4.05	2.63	5.00	5.00
Soil budget (inflow/outflow)	4.02	2.54	5.00	5.00
Weather patterns	4.02	2.54	5.00	5.00
Amphibian Communities	4.02	2.54	5.00	5.00
Soil health	3.98	2.45	5.00	5.00
Landscape dynamics (land cover, condition, connectivity, pattern, land change)	3.91	2.27	5.00	5.00
Small mammal communities	3.90	3.00	4.50	4.50
Viewshed	3.83	3.18	4.00	4.80
Human Demographic data (human density, traffic volume, land ownership patterns, land value)	3.76	1.90	5.00	5.00
Aquatic invertebrates (riverine and palustrine systems)	3.69	1.72	5.00	5.00
Fish communities (riverine systems)	3.69	1.72	5.00	5.00
Wet and dry deposition	3.60	2.00	5.00	4.00

Potential Vital Sign	Total Score	Management Significance	Ecological Significance	Cost Effectiveness and Feasibility
Erosion – slopes, lakeshores, banks	3.56	2.90	4.00	4.00
Yellow-billed cuckoo	3.56	1.40	5.00	5.00
Lepidoptera	3.56	2.40	4.00	5.00
Upland springs – vegetation communities	3.46	1.90	4.50	4.50
Insect diseases / outbreaks on ecosystem	3.39	1.81	4.50	4.33
Plant Pathogens	3.38	1.60	4.70	4.30
Flooding process along river / stream / lake	3.34	2.36	4.00	4.00
Other native pollinators	3.28	2.70	4.00	3.00
Lesser prairie chicken	3.29	0.72	5.00	5.00
Effects of park visitors on natural resources	3.25	3.09	3.38	3.33
Grasshoppers	3.18	2.20	3.50	4.50
Black-tailed prairie dogs	3.18	1.45	4.00	5.00
Fire Ants	3.16	0.90	4.50	5.00
Mineral, oil, and gas extraction	3.11	1.27	4.00	5.00
Carbon balance in soil	3.10	1.72	4.00	4.05
Visibility and particulate matter	3.09	1.72	4.00	4.00
Ferruginous hawk	3.04	1.09	4.00	5.00
Large carnivores	2.99	1.72	4.00	3.50
Volcanic cinder cone	2.98	0.45	5.00	4.00
Night sky	2.96	2.45	3.70	2.50
Wintering raptors	2.92	2.80	3.00	3.00
Sedimentation rates	2.91	1.27	4.00	4.00
Montane / grassland ecotone	2.91	1.27	3.50	5.00
Arkansas darter	2.89	0.72	4.00	5.00
Texas horned lizard	2.89	1.72	4.00	3.00
Lacustrine community – Plankton richness, abundance, and diversity	2.89	0.72	4.00	5.00
Burrowing Owl	2.86	0.90	3.75	5.00

Potential Vital Sign	Total Score	Management Significance	Ecological Significance	Cost Effectiveness and Feasibility
Arkansas river shiner	2.85	0.63	4.00	5.00
Feral Hogs	2.84	1.09	4.00	4.00
Cryptobiotic soils	2.74	1.36	4.00	3.00
Effects of Wildlife diseases	2.69	2.00	3.60	2.25
Soundscape	2.67	2.27	3.90	1.00
Southwestern willow flycatcher	2.58	0.45	3.50	5.00
Fecal Coliform	2.20	2.00	1.00	5.00
Mountain plover	2.16	0.90	3.00	3.00
Exotic ungulates	2.12	0.81	3.00	3.00
Mississippi kites	2.11	1.27	1.50	5.00
Medium-sized (meso) carnivores	2.10	2.00	1.50	3.50
Migratory stopover area	2.08	2.45	0.50	4.50
Reptile community	2.05	2.63	1.50	2.00
Zebra mussels	2.02	0.54	2.00	5.00
Swift fox	1.82	0.54	1.50	5.00
Bald Eagle	1.71	1.27	0.50	5.00
Non-vascular plants	1.64	1.09	1.00	4.00
Exotic Fish	1.60	1.00	1.00	4.00
Feral Dogs	1.56	0.90	1.00	4.00
Hunting / Game animals	1.52	0.81	1.00	4.00
Contaminants in fishery/food chain	1.49	1.72	0.00	4.00
Fishing	1.44	1.09	0.00	5.00
Endemic and keystone invertebrates (terrestrial systems)	1.42	1.54	1.50	1.00
Nutria	1.32	0.54	1.00	3.50
Raccoons	1.19	0.72	0.75	3.00
Erosion index	1.02	2.54	0.00^	0.00
Human Development (Road density, impervious cover, house density	0.84	2.09	0.00*	0.00

Potential Vital Sign	Total Score	Management Significance	Ecological Significance	Cost Effectiveness and Feasibility
Off-road vehicle use	**0.57**	0.54	0.50*	0.75
Tornadoes, record floods, ice storms	**0.54**	1.36	0.00*	0.00
Alberta Arctic butterfly	**0.18**	0.45	NR	NR
Townsend's big-eared bat	**0.18**	0.45	NR	NR

Appendix 1. Vital Signs Prioritization Workshop – Scoring Criteria

1. Management Significance (40%) – Ranked by parks prior to workshop
    a. Criteria and Scoring
        - There is an obvious, direct application of the data to a key management decision, or for evaluating the effectiveness of past management decisions.
        - Monitoring results are likely to provide early warning of resource impairment, and will save park resources and money if a problem is discovered early.
        - The vital sign is of high importance to park natural resource management goals.
        - Data are of high interest to the public.
        - There is an obvious, direct application of the data to performance (GPRA) goals.
        - Data are needed to give managers a better understanding of park resources so that they can make informed decisions. Contributes to increased understanding that ultimately leads to better management.
        - Parks are required to monitor this resource by legal mandate or identification in major park planning document. Examples might include species that are federally listed as endangered or threatened, are in the park's enabling legislation, or are an issue/species that is a major management concern.
        - In cases where data will be used primarily to influence external decisions, the decisions will affect key resources in the park, and there is a great potential for the park to influence the external decisions.
    b. Scoring
        - 5 = Agree with 7-8 statements
        - 4 = Agree with 5-6 statements
        - 3 = Agree with 3-4 statements
        - 2 = Agree with 2 statements
        - 1 = Agree with 1 statement
        - 0 = Do not agree with any statement
    c. The score will be the average of all of the park's scores. Each park will answer agree/disagree for the above 8 statements for each vital sign. The database will use these responses to calculate the score from 1 to 5. The final management significance score will be the average of the score for all 11 parks.

2. Ecological Significance (40%) – Ranked at workshop, done mostly by experts
    a. Criteria
        - There is a strong, defensible linkage between the vital sign and the ecological function or critical resource it is intended to represent (supported by ecological literature or knowledge of system).
        - The vital sign provides an early warning of changes to ecosystems or signifies an impending change in the ecological system. [Note: replace the term ecosystem with landscape or population, as appropriate.]
        - The vital sign responds to change in a predictable and explainable matter.
        - The vital sign has low natural variability (high signal to noise ratio).
        - There are reference conditions that exist within the region and/or threshold values that could be determined to assess deviance from a natural condition.
        - The vital sign reflects the capacity of key ecosystem processes to resist or recover from change induced by exposure to natural disturbances and/or anthropogenic stressors. [Note: replace the term ecosystem with landscape or population, as appropriate.]
        - The vital sign represents a resource or function of high ecological importance based on the supporting ecological literature and knowledge of the system.
    b. Scoring
        - 5 = Agree with 6-7 statements

- 4 = Agree with 4-5 statements
- 3 = Agree with 3 statements
- 2 = Agree with 2 statements
- 1 = Agree with 1 statement
- 0 = Do not agree with any statement

c. The facilitator will shoot for a consensus score. If consensus cannot be reached, the facilitator will ask each member of the group for their score and the average will be taken. On the database the notetaker will enter a number (with up to 1 decimal place) for the ecological significance score.

3. Cost of Implementation and Feasibility (20%) – Ranked at workshop, done mostly by experts
   a. Criteria
      - The cost of monitoring the vital sign is not prohibitive. Consider all costs such as capital equipment, data collection, and analysis.
      - The methods for the vital sign well established, repeatable, and are widely used and accepted.
      - The vital sign is being monitored by other entities so that efficiencies can be realized in data acquisition, analysis, or other means.
      - The methods of monitoring the vital sign are subject to limited human error, including errors due to different observers.
      - The sampling will have limited negative impact on park resources.
   b. Scoring
      - 5 = Agree with 5 statements
      - 4 = Agree with 4 statements
      - 3 = Agree with 3 statements
      - 2 = Agree with 2 statements
      - 1 = Agree with 1 statement
      - 0 = Do not agree with any statement
   c. The facilitator will shoot for a consensus score. If consensus cannot be reached, the facilitator will ask each member of the group for their score and the average will be taken. On the database the notetaker will enter a number (with up to 1 decimal place) for the ecological significance score.

Appendix 2. Schedule for Prioritization Workshop.

Tuesday January 24, 2006 – Ambassador Hotel, Amarillo, Texas		
Time	*Subject*	*Leader*
8:30-8:40	Welcome	Karren Brown
8:40-8:50	Group Introductions	
8:50-9:15	Overview of I+M and SOPN	Dusty Perkins
9:15-9:30	Prioritization Process	Dusty Perkins
9:30-9:50	Break	
9:50-12:00	Breakout Sessions – Evaluation of Potential Vital Signs	
	Wildlife	Dan Licht – Facilitator
	Plants and Soils	Mike DeBacker – Facilitator
	Water Quality and Aquatic Resources	Greg Shriver – Facilitator
	Landscape Level Issues	Dan Tinker – Facilitator
12:00-1:30	Lunch	
1:30-5:30	Breakout Sessions – Evaluation of Potential Vital Signs	Facilitators
7:00	Dinner at The Big Texan	Optional
Wednesday January 25, 2006 – Ambassador Hotel, Amarillo, TX		
8:30-9:00	Presentation of Prioritized Vital Signs List + Discussion and Day's Objectives	Dusty Perkins
8:30-11:00	Breakout Sessions – Review Top Vital Signs	Facilitators
11:00	Wrap-Ups By Breakout Group	Dusty Perkins
11:30-12:45	Lunch	
12:45-6:00	Tour at Alibates Flint Quarries National Monument	